In the nearly 35 years since biologist Starker Leopold noted that "management without knowledge would be a dangerous policy[1]," many more parks are in the system, threats are perceived to be more widespread and diverse, and complex issues routinely require specialized expertise. As a result, the need for scientific natural resource information has increased. Scientific information is available from many sources, but it is not often specific to the unusual management concerns frequently encountered in parks. The National Park Service must continue to foster research and its application in complex areas such as landscape ecology, the natural dynamics of ecosystems, the effects of fragmentation on resources, and resource restoration. During 1997, several developments indicate progress. The Park Service hired several senior scientists to ensure that park research and technical assistance needs are being met. A social science program was established to study the relationship between people and parks. The Inventory and Monitoring Program revised its priorities to become more effective in gathering baseline inventories in more parks.

Gathering Information

Mapping Alaska's coastline

by Rusty Yerxa

In 1989, the Exxon Valdez oil spill in Alaska's Prince William Sound destroyed invaluable coastal resources, many unknown and unmeasured. In the aftermath of the spill, the Alaska Region's resource managers recognized the need to map the location of coastal resources of parks to provide a baseline for measuring change and, in the worst case, to assess damage from future oil spills. Currently, no appropriate coastal resource inventory mapping protocol exists.

After evaluating the needs of Alaskan parks, resource managers determined that the mapping effort had to be accurate, flexible, and repeatable. Most importantly, it had to be affordable for parks that do not have the means to acquire expensive mapping expertise. Once established, the inventory protocol and its resulting GIS (Geographic Information System) layers can be used by coastal parks throughout the nation to collect, analyze, and display biological and physical shoreline data.

Developed by the resource management staff at Glacier Bay National Park and Preserve, with assistance from the Glacier Bay Field Station of the USGS Biological Resources Division, the new mapping effort uses aerial photography and GPS (Global Positioning System) technology to locate prominent shoreline features. During a low-tide "window," a two-person team determines the location of a variety of physical and biological resources, equipped with only a clinometer, a

rusty_yerxa@nps.gov
Wildlife Biotechnician; Glacier Bay National Park and Preserve, Alaska.

Distribution of *Fucus*, or rockweed, was just one of the numerous shoreline attributes recorded by resource managers at Glacier Bay National Park and Preserve (Alaska) during recent coastal mapping.

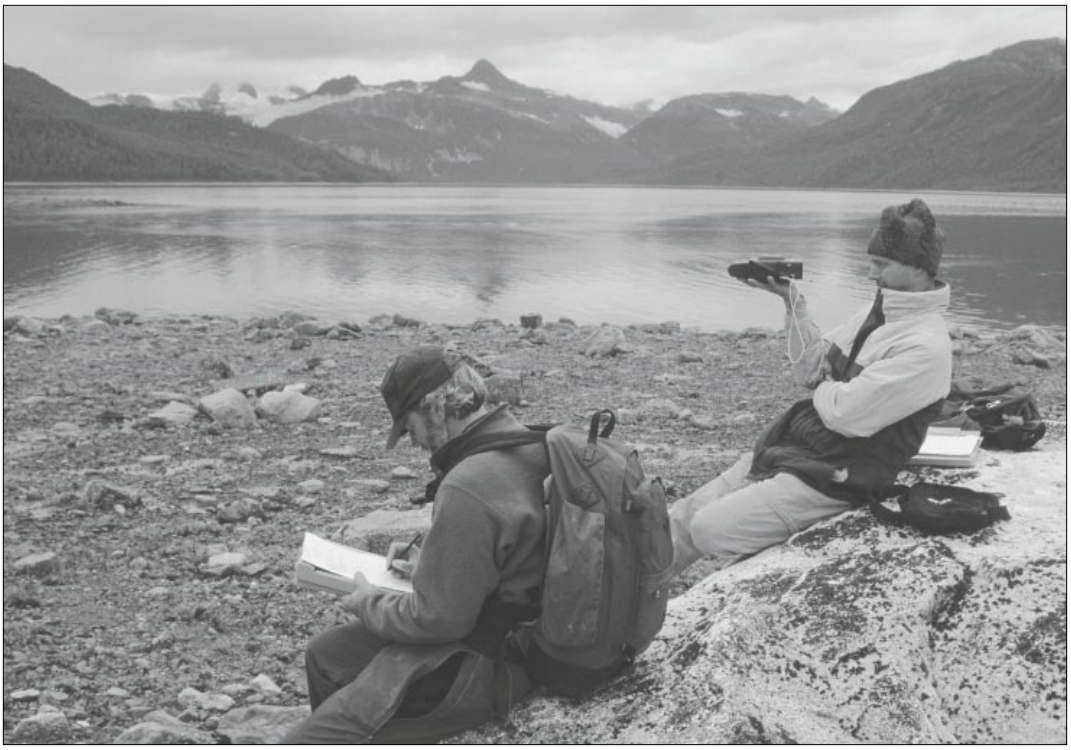
Scott Coll

[1] Leopold, A.S., S.A. Cain, C.M. Cottam, I.N. Gabrielson, and T.L. Kimball. 1969. *Wildlife Management in the National Parks.* Reprint from *Administrative Policies for Natural Areas of the National Park System*. USDOI—National Park Service.

Award Winner Profile

Senior scientist honored

Gary Davis, Senior Scientist and Research Marine Biologist at Channel Islands National Park, California, was honored with the 1996 Director's Award for Natural Resource Research during summer. This award recognizes outstanding contributions to technical expertise, continuity, and innovative thinking in research. Davis is a champion of ecological monitoring and scientifically based ecosystem management. He has shown these strategies to be reliable and cost effective and has developed monitoring protocols used widely by others. He is an inspiration among colleagues and a mentor of young scientists. His research, which has contributed to marine conservation in the Caribbean, Florida, and California, has explored the role of maritime parks as refugia to sustain and restore coastal fisheries and protect biodiversity. Also a leader, Davis has served as president of the American Academy of Underwater Sciences and the George Wright Society; he was a board member of the Natural Areas Association. He returned to the National Park Service recently after serving with the USGS Biological Resources Division, California Science Center, since 1993. His research insights and broad understanding of marine resources have been very valuable assets to the National Park Service and the Biological Resources Division. "To be recognized among peers feels good," Davis said. "These awards remind us all of what a job well done looks like."



Scott Cecil

During low tide, park staff used global positioning equipment to provide accurate shoreline locations and mapped slope, beach substrate type and composition, and distribution of intertidal life.

compass, an aerial photograph, a differential GPS receiver, and a one-page data sheet for each shoreline segment. Staff record resource attributes such as slope, beach substrate type, composition and distribution of intertidal biota, and other pertinent information. Each coastal segment is then precisely delineated on the aerial photo in the field, enabling future monitoring crews to recreate the segment exactly and detect any distributional changes over time.

The resulting product can be displayed in GIS format using ArcView™ and Microsoft Access™, enabling anyone with access to a GIS-capable personal computer to pull up a detailed assessment of a chosen section of coastline. A user can query any combination of attributes, from the simple (where are the seal haulouts?) to the complex (which bedrock beaches have steep slopes and tidepools?). The program also contains three digitized color photographs of each coastal segment that may be zoomed in on to show details of the actual shoreline.

Piloting the program on the coastline of a remote Alaskan park, staff encountered challenging logistics. Additionally, lack of quality base maps involved incorporation of complex and expensive ground control protocol components that would not be necessary for parks possessing adequate base maps. As the program moves from design to implementation, we expect that savings to protocol users will be substantial in the long run. Depending on shore complexity, we estimate that teams should be able to field-map 1–2.5 miles of coastline per hour at an estimated maximum total cost (including data processing) of $70 per mile, plus costs of nominal training and practice, protocol setup and customization, and logistics.

Researchers and park managers can use the resulting information to determine the location of study areas, as well as to monitor distributional change over time. Glacier Bay National Park will produce and distribute to the other Alaskan coastal parks a CD-ROM containing a detailed set of instructions on how to map their own coastlines, along with sample products from Glacier Bay. The protocol has been designed to be maximally scaleable to the needs and capabilities of a variety of parks.

New approach to paleontological surveys having success

by Vince Santucci

The record of life is well represented through fossils preserved within the national parks. Over 120 areas of the national park system have been identified as containing significant paleontological resources. A collective story ranges from Precambrian stromatolites exposed in Glacier National Park, Montana, to Ice Age mammal bones found throughout the Alaskan parks. A great diversity of petrified leaves, wood, pollen, shells, bones, teeth, eggshells, tracks, burrows, and coprolites exist within park strata. Museum collections throughout the country manage NPS paleontological specimens for research and public education.

Unfortunately, the management of nonrenewable paleontological resources in national parks faces increasing challenges. Movies such as "Jurassic Park" have elevated public interest in paleontology. The commercial market for fossils continues to escalate with a proportional rise in fossil resource theft from public lands. The lack of specific funding for paleontology programs within the National Park Service limits the stewardship activities of park resource managers. The fewer than ten professional NPS paleontologists must be innovative in competing for resource management funds in programs dominated by biological and cultural resource specialists.

A national approach to paleontological resource management and research is being advanced through a partnership between the NPS Geologic Resources Division and Fossil Butte National Monument (Wyoming). The NPS Paleontological Outreach Program is designed to provide professional support to national park areas lacking paleontological expertise. The outreach program was piloted at Yellowstone National Park in 1996 and 1997 and increased recognition of the importance of the park's fossil resources through a paleontological survey. The results of the survey will be published in a report that addresses issues related to fossil resource protection, interpretation, curation, and research. As a result of this project, similar surveys are underway or are being planned at Big Bend National Park, Colorado National Monument, Death Valley National Park, Grand Teton National Park, and the Alaskan parks. The outreach program is also working with the NPS Inventory and Monitoring Program and staff from the U.S. Geological Survey to develop a comprehensive paleontological resource database for the National Park Service.

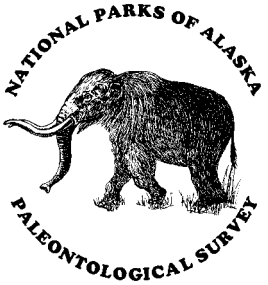
The issues associated with preserving fossils in national parks are just as real as those related to preserving geysers and grizzlies. This can clearly be demonstrated during a short hike through the world-renowned Crystal Forest at Petrified Forest National Park, Arizona. Photographs of the area from the early part of the century reveal pavements of fossil wood covering the ground. Today visitors find the same area nearly vacuumed clean of petrified wood specimens smaller than doorstop or paperweight size. Is it possible that this park could follow the same fate as the now abolished Fossil Cycad National Monument, in South Dakota? Management by neglect at Fossil Cycad led to the near complete loss of the fossil resource there and the reason the area was established as a national monument. In 1957, in an action rarely taken, Congress deauthorized this unit of the national park system.

Most of what is to be learned about the history of life remains buried within the earth. Through appropriate management in parks, partnerships, and the efforts of the Outreach Paleontology Program, part of the story will be revealed and interpreted by fossils discovered in the national parks.

Denali National Park and Preserve

Sarah Schlichtholtz, a paleontology intern funded by the Geological Society of America, surveys Denali National Park (Alaska) for fossil resources. Since 1985, paleontological surveys such as this have increased the number of parks known to contain significant fossil resources from 12 to 120. Sure to add to this number is the Outreach Paleontology Program that gathered momentum in 1997 and is assisting parks in beginning to manage this sometimes overlooked natural resource.

vincent_santucci@nps.gov
Resource Management Specialist and Paleontologist; Fossil Butte National Monument, Wyoming.



sue_consolo-murphy@nps.gov
Resource Naturalist, Center for Resources; Yellowstone National Park, Wyoming.

tami_blackford@nps.gov
Secretary, Center for Resources; Yellowstone National Park, Wyoming.

People and Preservation

Geologist's death leaves Yellowstone with deep loss and legacy

By Sue Consolo-Murphy and Tami Blackford

During his 28-year career with Yellowstone National Park (Wyoming, Montana, and Idaho), Geologist Roderick A. (Rick) Hutchinson amassed incomparable knowledge about the park's geysers and hot springs, which he shared with thousands of visitors and cooperative researchers from around the world. Rick and Diane Dustman, a private computer specialist who commonly worked with Rick on various projects, died in March 1997 in an avalanche while conducting backcountry monitoring of thermal features. Their deaths left the park and the geologic community with a deep loss. Rick was ever enthusiastic in sharing his knowledge of geothermal resources, from well-known geysers like Old Faithful and Steamboat, the world's largest, to remote areas such as the Heart Lake Geyser Basin, site of his last exploration. Though he preferred to escort visitors personally into the thermal basins, he also wrote or coauthored dozens of publications over the course of his career. In December 1997, a research symposium in his honor was held at the American Geophysical Union convention in San Francisco.

Geothermal features were a primary reason for Yellowstone's establishment and remain a major drawing card for visitors today. Despite this fact, the park has always spent less time and money on their study and management than on fish and wildlife. Only after Rick's death did other staff realize just how much knowledge was vested in one specialist. At a loss to answer information requests and continue monitoring and collaborative research, the park sought advice on how to replace its missing geologic expertise.

In July, a group of earth scientists from academia, the U.S. Geological Survey, and the National Park Service met to discuss the direction of Yellowstone's physical sciences program. They recommended that Yellowstone hire three professionals—a thermal geologist, a surficial geologist, and a hydrologist—to build expertise. They also proposed hiring more interpreters educated in geology and strongly supported the development of new visitor center exhibits to increase public understanding about physical resources.

Yellowstone National Park

Using a vacuum hose, Yellowstone Geologist Rick Hutchinson made several attempts during his career to remove coins, sticks, and other human-introduced debris from Morning Glory Pool. Vandalism of this kind can clog the hot spring vent, encouraging algae growth, and disturbing the historic appearance of the famous hot spring.

The consultants concluded that only full-time staff members with long-term expertise could fulfill many of the park's day-to-day responsibilities to oversee preservation and protection of geothermal features and systems. Yellowstone's hydrologic systems and issues also warrant attention. The park must complete the basic inventories of thermal features that Rick had been conducting, continue long-term geologic and hydrologic monitoring, facilitate geophysical research, minimize human impacts on geothermal systems, and enhance and disseminate general geologic information. These services will again be provided by the park, although they will no longer be found in just one very special person.

The Social Sciences

New Social Science Program makes strides

by Jean McKendry

As every park superintendent comes to know, the management of national parks necessarily involves the management of people—visitors, employees, concessioners, nearby communities, interest groups, and local governments all play roles in the national park system. From assessing the socioeconomic impacts of the 1997 flood in Yosemite, to resolving visitor use conflicts at Cape Canaveral or understanding international visitation patterns at Death Valley, social science is a necessary and important function of the National Park Service.

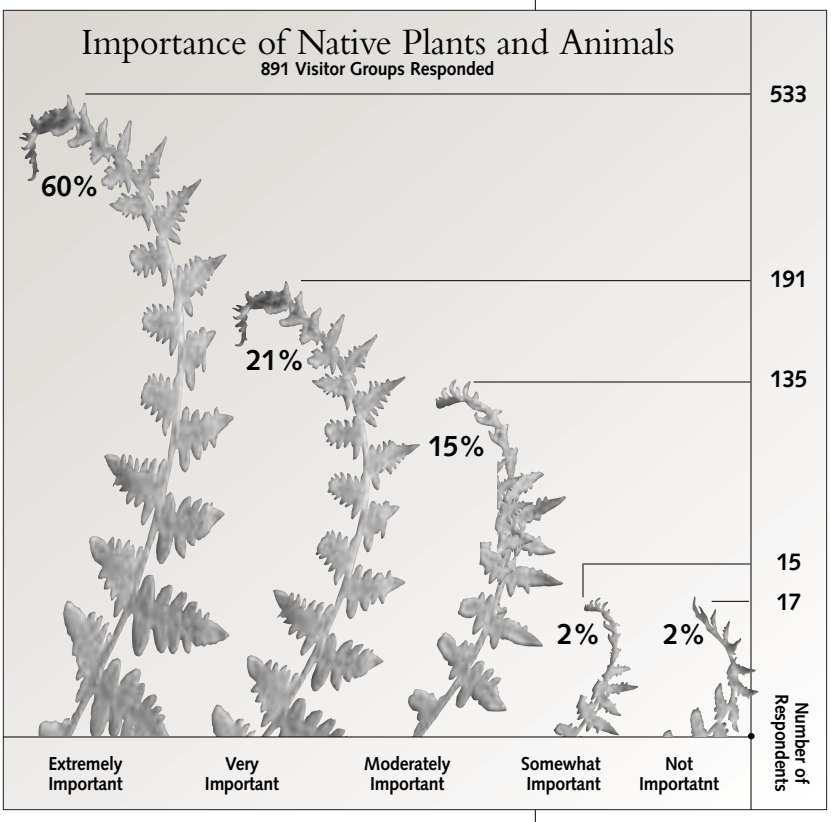
In 1996, the National Park Service approved the social science plan *Usable Knowledge: A Plan for Furthering Social Science and the National Parks*. Dr. Gary Machlis was appointed Visiting Chief Social Scientist. The Social Science Program reports to the Associate Director, Natural Resource Stewardship and Science. This program has as its mission to "conduct and promote state-of-the-art social science related to the mission of the National Park Service, and deliver usable knowledge to NPS managers and the public." In 1997, several key initiatives described in Usable Knowledge were completed. The program produced a social science research plan for the Harpers Ferry Center to improve the effectiveness of interpretive media, published a report on the future of Virgin Islands National Park, and assessed the economic and social impacts of the Yosemite flood; conducted several competitively awarded projects to meet national social science needs, including technical review of the NPS money generation model, studies on the economic effect of the 1995–96 shutdown of the national park system, and initial research on visitor reaction to the Recreation Fee Demonstration Program underway in 100 park units; and coordinated the Canon National Parks Science Scholars Program, which funds scholarships to support dissertation research on issues important to the national parks.

In addition, the Visitor Services Project maintained its busy schedule. This Project has been conducting visitor surveys at various park units since 1982, and has completed over 100 studies. The data are used to protect resources, save money, and improve visitor services. In 1997, the Project completed nine studies and initiated many more at 11 parks. The Project also published the fourth annual NPS customer service report, *Serving the Visitor 1997*.

Looking to the future, the Social Science Program received a base funding increase for fiscal year 1998. The program will develop and manage a customer service evaluation system dealing with park-related GPRA (Government Performance and Results Act) goals for all units of the national park system. The program will also initiate a long-term cooperative research program with a historically black college or university, focused on urban park units, cultural diversity, the needs of special populations, and visitor use management in high density parks. A social science web site for scientists and managers will become available through the NPS home page *ParkNet*.

jean_mckendry@nps.gov
Research Associate, NPS Social Science Program; Washington, D.C.

The visitor study, one service of the NPS Social Science Program, can illuminate visitor attitudes toward natural resource protection. For example, a 1996 study at Great Smoky Mountains National Park (Tennessee and North Carolina) found that native plants and animals are moderately to extremely important to 96% of summer park visitors.



gary_machlis@nps.gov
Visiting Chief Social Scientist;
National Park Service;
Washington, D.C.

Social science to improve employee safety

by Dr. Gary Machlis

Employee safety is essential to the mission of the National Park Service, and the agency faces several important challenges:

- a higher accident rate than other federal agencies with similar responsibilities,
- increasingly complex work tasks that emerge from the NPS mission,
- evolving policies and regulations, and
- limited budget, resources, and staff at all levels.

Since the mid-1970s, psychologists, geographers, engineers, and sociologists have performed studies of high-risk activities and general employee safety. Research has been conducted on high-profile events such as the Mt. St. Helens eruption, forest fires, and the Three Mile Island, Chernobyl, Exxon Valdez, and Challenger accidents. Research has also been conducted on more common activities, such as vehicle operation, logging, equipment inspection and maintenance, and handling of hazardous materials. Results from these studies have pointed to the importance of social factors—the social, psychological, cultural, and organizational variables that influence employee safety. Understanding these social factors is important to safety in the National Park Service.

National Park Service employees are often involved in operations in which safety is especially important, such as snow removal at Mount Rainier National Park (Washington). In 1997, the NPS Social Science Program began planning the research needed to improve employee safety.

Mount Rainier National Park

In 1997, the NPS Social Science Program (in cooperation with the Risk Management Division) began an effort to carefully plan the social science research needed to improve employee safety. A research plan can identify and prioritize research needs, increase the usefulness of research results, improve the delivery of information, and reduce costs. The Social Science Program has developed similar research plans for the South Florida units of the national park system and the Harpers Ferry Center.

Employee Safety in the National Park Service: A Social Science Plan includes several elements. It provides a policy analysis of NPS requirements and a rationale for social science research on employee safety. It provides a detailed review of social science literature relevant to employee safety in general and specifically to the agency; over 225 research articles are included in the review. The plan identifies the research priorities of NPS managers, supervisors, and employees, gathered through a workshop with the NPS Risk Management Council and interviews with other NPS employees and safety experts. Based on all this information, the plan includes a research agenda and action plan for employee safety research.

The draft plan was completed in 1997, and following a careful technical review, will be presented to the National Park Service for use in early 1998. Targeted and cost-effective research projects should be undertaken in 1998. The result should be critically needed research on employee safety, usable knowledge for NPS managers, and improved safety for NPS employees.

Air Quality

Information compels action to reduce air pollution

by Christine Shaver

The National Park Service has invested a lot of time and money monitoring air quality and studying how air pollution affects park resources. Even though we have no regulatory authority over the pollution sources, the National Park Service can provide others with the information and motivation they need to take action. Information provides the foundation for more stringent environmental standards, which in turn compel the development of additional measures to reduce pollution.

In July 1997, the Environmental Protection Agency adopted new national ambient air quality standards for ozone and fine particulate matter. Air pollution will need to be reduced significantly to comply with the new standards, particularly in the eastern United States and California where parks are besieged with air pollution problems.

In the West, a sweeping set of recommendations for improving visibility in national parks and wilderness areas on the Colorado Plateau was adopted by the Grand Canyon Visibility Transport Commission in 1996. The Park Service worked with eight western states, several dozen tribal nations, and hundreds of stakeholders to craft those recommendations. Turning them into action is now the challenge.

In October 1997, the Western Regional Air Partnership (WRAP) was formed to implement the commission's recommendations. The Department of the Interior is a charter member. The partnership is examining each of the commission's recommendations, developing more specific strategies, and designing institutional mechanisms to facilitate action by all the western states and tribal nations.

Much work remains to be done, but it is noteworthy that all the western states and tribes are focused on, and devoting resources to, the protection of visibility in our parks. That is because the Park Service provided them with scientifically sound information, worked collaboratively with them in designing remedial strategies, and otherwise convinced them that action was needed.

Based in part on the commission's work, the Environmental Protection Agency proposed new requirements for visibility protection programs in July 1997. Based on data collected over the past 20 years, the National Park Service suggested that a more ambitious schedule for restoring natural visibility was feasible—and necessary. Based on our experience in trying to use the data to reduce pollution, the Park Service recommended the EPA proposal simplify and expedite the process used to reduce pollution from existing facilities.

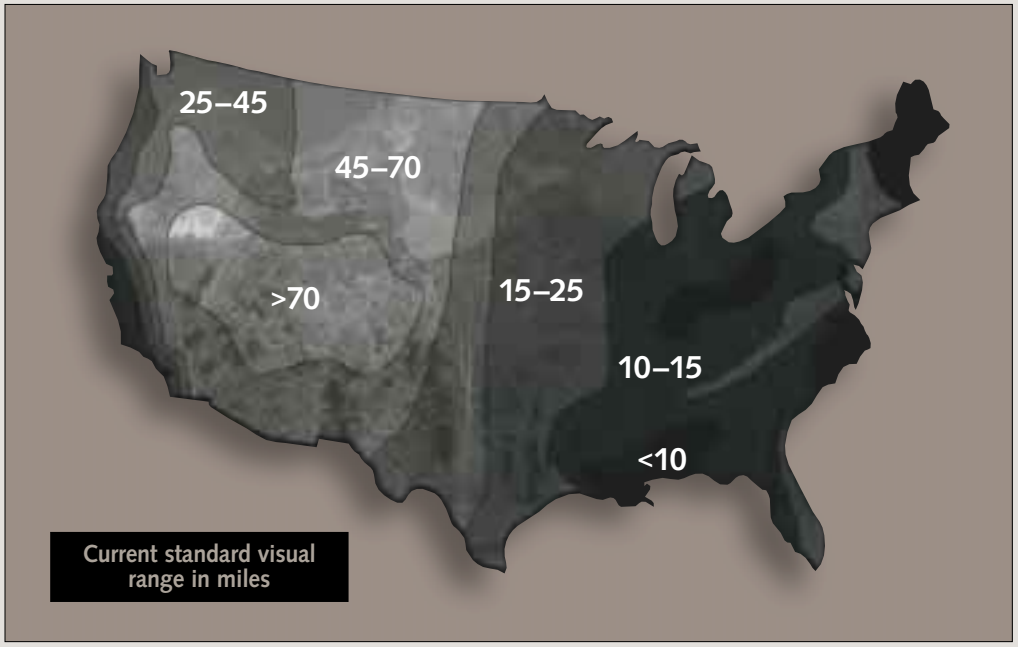
chris_shaver@nps.gov
Chief, Air Resources Division; Natural Resource Program Center; Lakewood, Colorado.

The status of air quality in nine Colorado Plateau Class-I area parks is generally good, according to a 1997 report by the Air Resources Division. The only documented impact of air pollution on air quality-related values is visibility reduction, yet no rapid changes are expected in the next decade. No impacts from ozone are documented, although little work has focused on the sensitivity of plants in this region to the gas.

Air Resources Division

Visibility impairment at Grand Canyon National Park (Arizona) is symptomatic of a regional air pollution problem for parks and wilderness areas. During 1997, the Western Regional Air Partnership formed to implement strategies aimed at improving visibility on the Colorado Plateau.

Proposed EPA regulations on reducing regional haze aim to restore natural visibility conditions through gradual reductions in air pollution. Given current pollution levels, the proposed EPA program would require 200-300 years to achieve natural visibility in the eastern United States. In the West, the goal is more optimistic at 60-90 years. The National Park Service recommended faster progress. (The map represents current standard visual range in miles.)



Data from Air Resources Division

jared_ficker@nps.gov
Legislative Affairs Specialist, NPS Office of Legislative Affairs; Washington, D.C.

Scientific Information & Legislation

Feral horses at Cape Lookout National Seashore

by Jared Ficker

A U.S. House of Representatives bill (H.R. 765) to ensure the maintenance of a herd of not less than 100 feral horses in Cape Lookout National Seashore (North Carolina) passed the House in the summer of 1997 and was very controversial. Associate Director Finnerty (Park Operations and Education) stressed in her testimony before the Senate Subcommittee on National Parks, Historic Preservation, and Recreation in October that the bill addresses a specific resource management decision that park managers make daily. Park superintendents make these decisions based on a myriad of interrelated factors, including the mission of the park; the best scientific information; input from local, state, and national interests; the policies of the National Park Service; and other considerations. The Park Service continues to believe that such decisions are best made at the individual park level due to their complexity. But, due to the limited scientific information regarding this issue and intense interest in it, the Administration supported this legislation provided it was amended so that (1) a requirement for keeping a specific herd level was removed, and (2) any adverse impact that the horses might have on the natural resources of the national seashore was considered. A variation of these requirements was included in the Senate-passed bill. The differences in the House and Senate-passed bills must now be resolved before a final bill is enacted. The experience with this legislation stresses the importance of relying on sound and thorough science as the basis for our resource management decisions.

Cape Lookout National Seashore

A feral horse takes a drink from Mullet Pond at Cape Lookout National Seashore (North Carolina).

Prairie Cluster Monitoring Program

Resource managers monitor prairie forb establishment at Wilson's Creek National Battlefield, Missouri.

Issue Update

Priorities revised for inventory and monitoring

by Gary Williams

The priorities used by the Washington Office to fund acquisition of the 12 basic inventory data sets for natural resource parks were revised and updated during 1997. These updates were based on several factors. In a few instances, parks had already completed some of the inventories, and better information about the need for geologic resources data was developed. New threats and other factors had made certain inventories more urgent. Having developed a better understanding of the linkages among the inventories, program managers could suggest a more efficient order in which to acquire data. Finally, new opportunities exist for leveraging funds to complete more of the inventories.

During the summer, parks submitted new priorities for consolidation into the new national listings. A work group consolidated the new information and closely followed the priorities set by the parks, except where changes were needed to complete inventories in a particular sequence. For example, parks scheduled for vegetation mapping first must assemble all base cartographic information. Nevertheless, the first 50 parks previously listed as top priorities for vegetation mapping were retained at the top of the new list, since some level of data acquisition had begun in most of those areas. A significant change is that vascular plants, birds, mammals, amphibians, reptiles, and fish each have their own priority listings now where they were formerly all lumped under "species inventories." By developing separate priority listings, the program can do a better job of addressing the most pressing needs for information about those taxonomic groups.

In a related activity, the inventory and monitoring committee reaffirmed the existing 12 basic inventory data sets being acquired through the program. The committee decided not to expand efforts to acquire data on other resources such as invertebrates, fossils, and wetlands, citing funding trade-offs and the specialized nature of these resources.

I&M Inventory and Monitoring

The first comprehensive report of the Inventory & Monitoring Program was published in 1997 and is available from the Natural Resource Information Division in both hard copy and electronic form (www.nps.gov/pubs/I&Mann96). The report addresses natural resource inventories and data management and describes the status of natural resources in 11 park units that conduct prototype ecological monitoring.

gary_williams@nps.gov
Inventory and Monitoring Coordinator, NPS Natural Resource Information Division; Natural Resource Program Center; Fort Collins, Colorado.